Spiking Neural Networks (SNN) are the third generation of neural networks. They are more bioinspired (i.e. handling spikes) and are usually considered as more energy efficient than their classical-coded counterparts. The energy gain comes from (1) the lightness of the base operation (accumulation, instead of multiplication-accumulation as in classical coding) and (2) the activity sparsity thanks to the spike coding. The other advantage of SNNs is that they can exploit information in the Temporal Domain, as well as information contained in the Spatial Domain, while classical-coded neural networks can only exploit the latter one. SNNs are thus considered as good candidates for future Edge AI implementations, exploiting spatial and temporal information from various sensors.

MIAI PhD

SECTOR**:** Higher Education Institution

LOCATION: France, Grenoble

RESEARCHER PROFILE:

□ *First stage researcher*

INSTITUTION: Univ. Grenoble Alpes, University of Innovation

One of the major research-intensive French universities, Univ. Grenoble Alpes[1], enjoys an international reputation in many scientific fields, as confirmed by international rankings. It benefits from the implementation of major European instruments (ESRF, ILL, EMBL, IRAM, EMFL*). The dynamic ecosystem, grounded on a close interaction between research, education and companies, has earned Grenoble to be ranked as the 5th most innovative city in the world. Surrounded by mountains, the campus benefits from a natural environment and a high quality of life and work environment. With 7000 foreign students and the annual visit of more than 8000 researchers from all over the world, Univ. Grenoble Alps is an internationally engaged university.

A personalized Welcome Center for international students, PhDs and researchers facilitates your arrival and installation.

In 2016, Univ. Grenoble Alpes was labeled "Initiative of Excellence". This label aims at the emergence of around ten French world class research universities. By joining Univ. Grenoble Alpes, you have the opportunity to conduct world-class research, and to contribute to the social and economic challenges of the 21st century ("sustainable planet and society", "health, well-being and technology", "understanding and supporting innovation: culture, technology, organizations" and "Digital technology").

* ESRF (European Synchrotron Radiation Facility), ILL (Institut Laue-Langevin), IRAM (International Institute for Radio Astronomy), EMBL (European Molecular Biology Laboratory), EMFL (European Magnetic Field Laboratory)

Key figures:

- 50,000+ students, including 7,000 international students
- 3,700 PhD students, 45% international
- 5,500 faculty members
- 180 different nationalities

[1] https://edu.univ-grenoble-alpes.fr/en/

- 1st city in France where it feels good to study and 5th city where it feels good to work
- ISSO: International Students & Scholars Office affiliated to EURAXESS

MANDATORY REFERENCES:

PROJECT TITLE: *MIAI @ Grenoble Alpes*
SUBJECT TITLE: **Design and verification of a Spiking Neural Network accelerators with Resistive RAM synapses**
RESEARCH FIELD: Engineering > Electrical engineering, Technology > Nanotechnology
SCIENTIFIC DEPARTMENT (LABORATORY'S NAME): CEA/LETI - DACLE/SCSN/LISAN team and TIMA Laboratory, Amfors team
DOCTORAL SCHOOL'S: EEATS
SUPERVISOR'S NAME: VALENTIAN Alexandre/ANGHEL Lorena/VATAJELU Ioana

SUBJECT DESCRIPTION:

The Spiking Neural Networks (SNNs) are considered promising solutions for Embedded AI, mainly due to their bio-inspired event-driven operation. The SNNs are of interest to several communities: neurobiology, mathematics, deep learning, computational neuroscience and neuromorphic hardware. Their study originates from the desire to understand the human brain, from how it computes sensory input, to the yet unknown, manner of thinking. They are usually considered as more energy efficient than their classical-coded counterparts. SNNs are intrinsically dynamic and best-suited to act as spatio-temporal filters for processing audio- and video-like signals. Their energy gain comes from (1) the lightness of the base operation (accumulation, instead of multiplication-accumulation as in classical coding) and (2) the activity sparsity thanks to the spiking event coding. They open up new possibilities for unsupervised learning deployment, implementation of recurrent networks, performing probabilistic inference, etc.).

The Grand Challenge of this research activity is to enable the arrival of the third generation of Neural Networks, namely the spiking ones. The scientific challenges is to design a scalable and flexible SNN architecture: adaptable to different learning algorithms, able to handle tasks such as inference and learning (online, supervised, unsupervised, probabilistic, etc.). They will be designed and fabricated in hybrid nanoscale CMOS and Non-Volatile technology such as resistive, or magnetic, etc, enabling very high synaptic density. The obtained circuits will be employed in embedded applications, in the industrial, health and automotive sectors.

The PhD student will join a multi-disciplinary team of machine learning specialists, circuit designers and technologists, working on industrial, health and automotive Edge AI applications.
The PhD student will have access to state-of-the-art facilities, enabling him/her to tape-out circuits in advanced technology nodes.
The research work will consist in:

- Design and verification of basic computation kernels: computing clusters such as LSTM or GRU very appealing for Recurrent Neural Networks, or other learning and inference clusters with hybrid non-volatile/CMOS technologies.
- Working on the scalable architectures, starting from high-level models (SystemC or SystemVerilog) to assess key parameters, e.g. latency, network bandwidth, memory capacity.
- Implementing the optimized architectures such as "near memory" with distributed memory modules or/and "in-memory" computing styles using target technology node.
- Defining the API for the architecture, to render it programmable from Deep Learning frameworks, such as TensorFlow Lite for classification tasks

Expected skills

Technical: Analog/Digital integrated electronics (design, HDL modeling languages, CAD tools), Pyton/C/C++ and scripting. Knowledge about front end/back end, assembly language, machine learning algorithms, data science, etc.

Personal: Determination, perseverance, trustworthiness, autonomy, adaptability, initiative, good communication skills

Languages: English: at least B2 equivalent, excellent reading and writing level, good speaking level. Fluency in French is a plus but it is not mandatory.

ELIGIBILITY CRITERIA

Applicants must hold a Master's degree (or be about to earn one) or have a university degree equivalent to a European Master's (5-year duration).

Applicants will have to send an application letter in English and attach:

- Their last diploma and transcript of last 2 years scores.
- Their CV focusing on the technical topics developed and implemented in projects and labs
- A short presentation of their scientific project (2 to 3 pages max)
- Letters of recommendation are welcome.

Address to send application: alexandre.valentian@cea.fr; lorena.anghel@grenoble-inp.fr; ioana.vatajelu@univ-grenoble-alpes.fr